Japanese Rice Market Liberalization: A Competitive Equilibrium Approach

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Abstract

This paper quantifies the effect of Japanese rice imports on the Japanese rice market with special attention to the farmland market in the year 2000. Tariff and quota policies do not affect the equilibrium price of rice and rent significantly given the current acreage controls. The removal of the acreage control program would reduce the autarky price of rice by 30%. With free importation of rice into Japan, the price of rice would be halved, and the potential increase in the consumer surplus could be 0.3% of the 1995 Japanese GDP.

JEL Classification: F14, Q17, Q18

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I. Introduction

This paper quantifies the effect of Japanese rice imports on the Japanese rice market with special attention to the farmland market in the year 2000. More specifically, it first shows the results of simulating domestic equilibrium with the current acreage control program as a base line. Second, it compares the results of simulating the importation of 758,000 tons of white rice as the minimum access quota temporarily approved by the GATT Uruguay Round Accord in the year 2000, and the importation of rice subject to a specific tax within the limits of the same Accord after the removal of the quota under the current acreage control program. This comparison is relevant because Japanese government promises to review its policy on rice imports once again in the year 2000, and it is quite likely that Japan will set a tariff within the limits of the GATT Uruguay Round Accord instead of removing the current minimum access import quota which is valid only until the year 2000. Third, it shows the results of simulating a domestic equilibrium and a free-import equilibrium without an acreage control program. These simulations are useful for the quantification of the welfare losses due to import restrictions on rice.

The innovation in this research is that it integrates the study of Japanese rice imports and the literature on the Japanese farmland market using a competitive equilibrium approach. By solving for the competitive equilibrium in the rice and farmland markets simultaneously under the assumption that the farmland market works within the flat agricultural areas, the paper quantifies the effect of importation and the removal of acreage controls on the Japanese price of rice as well as rent and the equilibrium farm size distribution in the flat agricultural areas. The issues addressed in this study are also examined in Fujiki [1993]. However, given the new world trade system initiated by the GATT Uruguay Round Accord, this paper makes the assumptions for policy simulations more realistic, and uses more recent data.

Former Japanese studies on the importation of rice into Japan, including the pioneering study by Oga [1988], and work by the Forum for Policy Innovation [1990] and Kome Seisaku Kenkyukai [1991], predict substantial decreases in the price of rice and relatively small decreases in the domestic supply of rice. This is because those studies assume a relatively inelastic aggregate supply function for rice with respect to its price, and that Japan can import as much rice as it wants at a constant world price. Given the hike in the world price of rice after Japan imported rice to cope with the bad harvest in 1993, the small country assumption seems unsound. Apart from this shortcoming, the previous models appear to be useful for the sake of short run forecasts. However, observing a substantial decline in the price of rice, farms might reduce the level of rice production more than those models suppose. In particular, if some of the decrease in the price of rice coincides with a reduction in the rent for farmland and a reduction in the output per area, it may be possible to find an equilibrium with a large reduction in the output per area and the rent for farmland, and a small decrease in the price of rice. Therefore, to predict long-run equilibria, it is desirable to integrate the analysis of the Japanese rice and farmland markets.

In the mean time, Japanese studies on the farmland market going back to Imamura [1968] and Kaji [1973] have focused on the possibility of large-scale tenant farming given institutional farmland market imperfections (see details on farmland market regulation, for example, in Hayami [1991]). Generally, those studies discuss the amount of rent that the larger farms are willing to pay and the minimum rent that the small farms are willing to receive, but do not examine equilibria in the farmland and rice markets simultaneously. However, this study predicts the equilibrium farm size distribution, the equilibrium price of rice, and the equilibrium rent in the flat agricultural areas using a competitive equilibrium approach.

In the year 2000, the Japanese government is likely to levy a specific tax on the importation of rice within the limits of the GATT Uruguay Round Accord, instead of removing the minimum access quota temporarily approved by the Accord. The results of the simulations demonstrate that the equilibrium with rice imports subject to such a tariff is not substantially different from equilibrium with rice imports based on the minimum access import quota, as long as the current acreage control program is effective. It is also shown that the removal of the acreage control program will reduce the autarky equilibrium price of rice by 30% compared with the autarky equilibrium price with the acreage controls. With free importation of rice into Japan, the price of rice will be halved compared with the autarky price of rice, and the potential increase in the consumer surplus amounts to 0.3% of the 1995 Japanese GDP.

The organization of this paper is as follows. Section II introduces the model, Section III explains the data, Section IV reports the results of the simulations, and Section V concludes the paper.

II. The Theoretical Model

I classify Japanese agricultural land into two types: the flat agricultural areas and the rest of Japan. Within the flat agricultural areas, I assume that farms can adjust all inputs (such as variable inputs, capital, labor and farmland) for production, given the prices of variable inputs, capital, labor and rent. Within the rest of Japan, I assume that farms only adjust variable inputs for production given the price of variable inputs, and that the farmland market does not work. The equilibrium price of rice equates the aggregate demand for rice with the aggregate supply of rice, while the equilibrium rent equates the demand for farmland by the farms in the flat agricultural areas with the total farmland available in those areas given the equilibrium price of rice. The details of the theoretical model are explained in turn.

A. Technology in the Flat Agricultural Area

Suppose farm *i* in the flat agricultural areas produces rice and has the following production function:

$$y_i = A_i V_i^{\alpha 1} K_i^{\alpha 2} L_i^{\alpha 3} T_i^{\alpha 4}, \qquad (1)$$

where *y* is the output of rice, *A* is a productivity parameter, *V* represents variable inputs such as fertilizer and seed, *K* is capital, *L* shows hours worked, *T* corresponds to the area in rice cultivation, and subscript *i* means farm *i*. Suppose that factor markets are competitive and a farm maximizes profits:

$$\Pi_i = pA_i V^{\alpha 1} K_i^{\alpha 2} L_i^{\alpha 3} T_i^{\alpha 4} - p_V V_i - p_K K_i - p_L L_i - p_T T_i, \qquad (2)$$

where p is the price of rice, p_j (*j*=*V*, *K*, *L*, *T*) is the factor price of input *i*, and $\theta = \alpha 1 + \alpha 2 + \alpha 3 + \alpha 4 < 1$. The profit function of farm *i* will be:

$$\Pi_i(A_i, p, p_V, p_K, p_L, p_T) = (1-\theta) A_i^{\frac{1}{1-\theta}} p^{\frac{1}{1-\theta}} [(\frac{\alpha 1}{p_V})^{\alpha 1} (\frac{\alpha 2}{p_K})^{\alpha 2} (\frac{\alpha 3}{p_L})^{\alpha 3} (\frac{\alpha 4}{p_T})^{\alpha 4}]^{\frac{1}{1-\theta}}. \qquad (3)$$

Using Hotelling's lemma, the supply of rice by farm i will be:

$$y_i(A_i, p, p_V, p_K, p_L, p_T) = \frac{\partial \Pi_i}{\partial p} = A_i^{\frac{1}{1-\theta}} p^{\frac{\theta}{1-\theta}} (\frac{\alpha 4}{p_T})^{\frac{\alpha 4}{1-\theta}} [(\frac{\alpha 1}{p_V})^{\alpha 1} (\frac{\alpha 2}{p_K})^{\alpha 2} (\frac{\alpha 3}{p_L})^{\alpha 3}]^{\frac{1}{1-\theta}}, \qquad (4)$$

and the demand for land by farm i will be:

$$T_i(A_i, p, p_V, p_K, p_L, p_T) = -\frac{\partial \Pi_i}{\partial p_T} = A_i^{\frac{1}{1-\theta}} p^{\frac{1}{1-\theta}} \left(\frac{\alpha 4}{p_T}\right)^{(1+\frac{\alpha 4}{1-\theta})} \left[\left(\frac{\alpha 1}{p_V}\right)^{\alpha 1} \left(\frac{\alpha 2}{p_K}\right)^{\alpha 2} \left(\frac{\alpha 3}{p_L}\right)^{\alpha 3}\right]^{\frac{1}{1-\theta}}. \qquad (5)$$

By aggregating Eq. (4) and Eq. (5), I have supply function for rice *As*1 and demand function for land *Td* given p_j ($j=V, K, L$) and *A*,

$$As1(p, p_T) = \sum_i A_i^{\frac{1}{1-\theta}} p^{\frac{\theta}{1-\theta}} \left(\frac{\alpha 4}{p_T}\right)^{\frac{\alpha 4}{1-\theta}} \left[\left(\frac{\alpha 1}{p_V}\right)^{\alpha 1} \left(\frac{\alpha 2}{p_K}\right)^{\alpha 2} \left(\frac{\alpha 3}{p_L}\right)^{\alpha 3}\right]^{\frac{1}{1-\theta}}, \qquad (6)$$

$$Td(p, p_t) = \sum_i A_i^{\frac{1}{1-\theta}} p^{\frac{1}{1-\theta}} \left(\frac{\alpha 4}{p_T}\right)^{(1+\frac{\alpha 4}{1-\theta})} \left[\left(\frac{\alpha 1}{p_V}\right)^{\alpha 1} \left(\frac{\alpha 2}{p_K}\right)^{\alpha 2} \left(\frac{\alpha 3}{p_L}\right)^{\alpha 3}\right]^{\frac{1}{1-\theta}}. \qquad (7)$$

B. Farms in the Rest of Japan

As can be seen in Table 1, almost all of the labor inputs are family labor, and except for the larger scale farms in the Tofuken region, farms are likely to cultivate their own land. Why did such a farmland distribution appear? The answer lies in the history of Japanese farmland regulation (see, for example, Hayami [1991]). The Farmland Reform (1946-50) and the Agricultural Land Law created a large number of small-scale, owner-cultivator farms in Japan under the upper limit on farmland ownership, and prevented the owners from once again becoming poor tenant farmers. This avoided a prevalence of large-scale, absentee landloads. For example, rent was kept at a lower level, and landloads were not allowed to terminate a farmland lease contract at their will, even at the end of the contract period. Part-time farming became possible during the 1960s without requiring migration due to an increase in off-farm job opportunities and the introduction of machines which enabled the elderly and women to participate in farm labor. At the same time, the increase in the price of farmland made it impossible for the usual farmers to purchase farmland to expand. Small farms did not rent their own land even after the removal of the upper limit on the ownership of farmland in 1970, or after the legal arrangements such as the 1975 Farmland Utilization Promotion Law.

There are several reasons why the farmland market does not work. First, larger farms may not be profitable enough to take over small farms. Second, farms often have scattered ownership and irregularly shaped paddies, which prevents the use of efficient, large-scale machines. Third, there is a scarcity of flat land. Finally, farms that expect to convert their paddies in the near future do not want to rent their land because they want to be able to seize on the best time for conversion. Given such a historical background, it is useful to analyze a model in which the allocations of machines, labor and land are given. Specifically, suppose that farm *k* in the rest of Japan produces rice according to the following production functions:

$$y_k = A_k V_k^{a1} T_k^{1-a1}, \qquad \textbf{(8)}$$

and

$$T_k = B_k K_k^{e} L_k^{g}. \qquad \textbf{(9)}$$

Eq. **(8)** is called the "Biochemical Technology Production Function" and Eq. (9) is called the "Mechanical Production Function" by Egaitsu [1978]. Eq. **(8)** is not only useful for the fairly precise prediction of output per area as can be seen in Fujiki [1993], but it can also be used to show that the shift in the supply curve after the removal of acreage controls is almost proportional to the increase in the area in rice cultivation. Eq. **(9)** is consistent with the empirical observation that almost all of the farms have their own machines, and that the larger farms generally have faster and larger machines. I assume that *K*, *L*, and *T* reflect the historical background explained in this section. Assuming the profit maximization of farms, the aggregate supply for rice in the rest of Japan will be

$$As2(p) = p^{\frac{a1}{1-a1}} \left(\frac{a1}{p_V}\right)^{\frac{a1}{1-a1}} \sum_k (A_k T_k^{1-a1})^{\frac{1}{1-a1}}. \qquad \textbf{(10)}$$

Observe that if $a1 = 0.15$, then Eq. (10) corresponds to a conventional aggregate supply function for rice with a constant price elasticity of supply of 0.18, as used in the Forum for Policy Innovation [1990].

C. Equilibrium

Suppose there are $\overline{T}$ hectares of paddies available for rice production in the flat agricultural area, and that all of those paddies are supplied only for the sake of rice production. Note that due to the Agricultural Land Law, farmers cannot convert their paddies at their will, at least in the short run, but they are sometimes allowed to use them for non-agricultural purposes. Hence, the Japanese paddy field area declined at an annual rate of 0.7% between 1980 and 1992 according to Kako, Gemma and Ito [1997]. It is hard to imagine a situation where farmers would create new paddies for the sake of rice production. Therefore, $\overline{T}$ could be thought of as an upper limit on the supply of paddies. In reality, the upper limit is determined by the government acreage control program. Suppose further that the domestic aggregate demand for rice, *Ad(p)*, depends only on the price of rice, *p*. Under these assumptions, there are two equilibrium conditions in the markets for rice and farmland,

$$As1(p, p_T) + As2(p) = Ad(p), \tag{11}$$

and

$$\overline{T} = Td(p, p_T). \tag{12}$$

Solving Eq. (11) and Eq. (12) simultaneously yields the equilibrium price of rice, *p*, and the equilibrium rent, p_T, given p_j (*j*= *V*, *K*, *L*) and *A*. First, a given *p* in Eq.(12) determines a unique p_T that clears the land market in the flat agricultural area, $p_T = p_T(p, \overline{T})$, since the right hand side of Eq. (12) is a decreasing function of p_T given *p*. Plugging $p_T = p_T(p, \overline{T})$ into Eq. (11) yields the equilibrium value of *p** that satisfies Eq. (11). Finally, the $p_T{}^* = p_T(p^*, \overline{T})$ which satisfies Eq. (11) and Eq. (12) simultaneously is found. Note that if there are R regions separated geographically, and the assumption of a single farmland market is not plausible, Eq. (11) and Eq. (12) should be modified as follows:

$$\sum_{r=1}^{R} As1_r(p, p_{Tr}) + \sum_{r=1}^{R} As2_r(p) = Ad(p), \tag{13}$$

$$\overline{T}_r = Td_r(p, p_{Tr}),\ r = 1, ..., \mathrm{R}. \tag{14}$$

Here, subscript *r* represents region *r*. To quantify the results of removing the current acreage control program, regard $\overline{T_r}$ as the acres of paddies potentially available for rice production under the assumption that the current acreage control program is binding. To examine the effect of rice imports, one can add the overseas supply curve of Japonica rice to the left hand side of Eq. (13).

III. Data

A. The Definition of Flat Agricultural Area

The Current Situation of Japanese Farmland, published by the Ministry of Agriculture, Forestry and Fisheries in 1994, classifies Japanese farmland by the slope and size of its paddy fields. I assume the flat agricultural areas include all of the Hokkaido region, and 32.9% of the Tofuken region. This assumption is based on the statistical evidence that 78.6% of paddies whose size is larger than 0.3 ha in the Hokkaido region and 32.9% of paddies whose size is larger than 0.3 ha in the Tofuken region exist in the Agricultural Promotion Area whose slopes are less than 1/100 as can be seen in Table 2. By law, the paddies in the Agricultural Promotion Area are supposed to be used for agricultural production. The consolidation of smaller paddies into a paddy larger than 0.3 ha usually allows farmers to use larger machines efficiently and results in the working of an efficient farmland market based on either sharing of machines or land lease contracts according to the *White Paper on Agriculture* (1996). Slopes less than 1/100 (the paddy rises less than one meter within a hundred meters square) correspond to an engineering limitation that the consolidation of small paddies into a large paddy, say 1.0 ha, by the government land improvement program is economically feasible according to *The Current Situation of Japanese Farmland.* Since the theoretical model in Section II assumes that the farmland market works in the flat agricultural areas, I assume that 32.9% of paddies in the Tofuken region, where the assumption of an active farmland market seems plausible, represent flat agricultural land. Note that about 80% of paddies in the Hokkaido region satisfy the condition for flat agricultural land defined above. However, the total area of paddies in the Hokkaido region accounts for less than 10% of all the paddies in Japan, as can be seen in Table 2. Hence it is safe to assume for simplicity that all of the paddies in the Hokkaido region are located within flat agricultural areas. Therefore, in Eqs. (13) and (14), r = 1 and 2: the Tofuken region and the Hokkaido region respectively, and $As2_2 = 0$.

B. Farm Size Distribution

The *Agriculture Census 1995* groups rice producing farms in each region by the size of the area in rice cultivation, and reports the total number of farms and the total area in rice cultivation managed by those groups of farms in each region as of February 1995. I assume that within each group, farm size distribution is concentrated at the mean farm size. I construct average farm size data on eight groups for the Tofuken region: below 0.3, 0.3-0.5, 0.5-1.0, 1.0-2.0, 2.0-3.0, 3.0-5.0, 5.0-10.0, and more than 10.0 ha farms; and seven groups for the Hokkaido region: below 0.3, 0.3-0.5, 0.5-1.0, 1.0-3.0, 3.0-5.0, 5.0-10.0, and more than 10.0 ha farms. This data is presented in Table 3. The farms of less than 1.0 ha in the Tofuken region account for more than 50% of all farms and 40% of the area in rice cultivation, while farms in the Hokkaido region are larger than those in the Tofuken region.

The *Agriculture Census 1995* also reports the total area of paddies managed by each group of farms. Due to the acreage control program, some paddy fields are not used for rice production, or are simply abandoned. I define the potential area in rice cultivation as the difference between the total area of paddies managed by farms and the total area of abandoned paddies. I assume this is the area of paddies which would have been used for rice production if Japan removed its acreage control program.

Unfortunately, the acreage control program in 1994 (588,215 ha) was rather modest as a result of the bad weather in 1993, and the area in rice cultivation could be high as input into a simulation that assumes normal weather. Moreover, the figures in the *Agricultural Census 1995* are based on self reporting by farms and are typically underestimated compared with the area in rice cultivation shown in *Crop Statistics*, which is based on a sampling measurement by statistical officials. Therefore, I multiply the area in rice harvest shown in the *Agricultural Census 1995* by 1.05 in the Tofuken region, and 0.83 in the Hokkaido region, to make the area in rice harvest consistent with the *Crop Statistics* data from 1992. The year 1992 was chosen because in that year, domestic demand and supply were almost equal. Moreover, the acreage control program was applied to approximately 30% of all paddy fields in Japan in the early 1990s, and former studies in this field normally assumed that the area of total paddy field shown in the *Statistics of Cultivated Land and Planted Area* would be used for the production of rice once the acreage control program was removed. Therefore, I multiply the data on the potential area in rice cultivation shown in the *Agricultural Census 1995* by 1.26 in the Tofuken region, and 1.25 in the Hokkaido region, to make the total potential area in cultivation consistent with the total paddies in Japan shown in *Statistics of Cultivated Land and Planted Area* (1996). Unfortunately, the

Agricultural Census 1995 does not group the rice farms by the slope of their paddies. Therefore, I simply assume the same farm size distribution for both flat agricultural areas and the rest of Japan.

In summary, I assume that the area in rice cultivation could increase 30% if the acreage control were removed, which makes the comparison of my result and the results of former studies easier. In the Tofuken region, 32.9% of paddies exist within the flat agricultural areas, and in the Hokkaido region, all of the paddies exist within the flat agricultural areas.

C. Technology of Farms

In order to estimate the level of technology employed by farms, this study uses the *Kome Seisanhi Chosa* [Survey of Rice Production Costs, hereafter *KSC*] data from farms selling rice between 1991 and 1994. Pre-1991 data are not used because in 1991 the *KSC* changed its method of compiling statistics in several ways; it ceased to include the depreciation cost of already fully depreciated machines, and it changed the wage used to evaluate the cost of family labor. Data on the Hokkaido region and the Tofuken region are prepared separately.

The *KSC* classifies production costs into ten categories; Seed and Seedlings, Fertilizers, Agricultural Chemicals, Light, Heat and Power, Other Purchased Inputs, Water Resources, Rent and Charges, Building and Land Improvement, Agricultural Implements, and Labor. In addition, it reports the imputed interest payments and market land rental rates, and shows the average cost per 0.1 ha. I have grouped average data on two regions and each region has a breakdown of grouped average data by farm size measured by the area in rice cultivation. To make the farm size distribution consistent with the *Agricultural Census 1995*, I have averaged the data on 1.0-1.5 ha and 1.5-2.0 ha farms for the Tofuken region and the data on 1.0-1.5 ha, 1.5-2.0 ha, and 2.0-3.0 ha farms for the Hokkaido region.

I constructed several variables for the analysis. Variable inputs, V, is the sum of the costs of seeds, fertilizers, agricultural chemicals and other purchased materials such as soil used for the nursery. The cost of variable inputs is deflated by the price index, p_v, constructed from the corresponding items in the *Nouson Bukka Chingin Toukei* [Rural Price and Wage Survey, hereafter *NBCT*] (1990 base, transformed as 1994 = 1) with the expenditure shares as weights. Machinery, K, is the sum of the depreciation cost of agricultural implements, rent and charges, deflated by p_k, the price index constructed from corresponding items in the *NBCT* with the expenditure shares as weights. To be precise, the cost of agricultural implements should be treaded as a service from the capital stock. However, for consistency with previous studies, it is treated as a flow variable. Hours worked, L, is the sum of the hours worked by men and women. Note that for women, 1 hour of actual labor is counted as 0.75 hours. This weight comes from the 25% differential in rural part-time wages shown in the *NBCT* between men and women during the 1991-1994 period. The *KSC* evaluates the family labor cost using the wages paid by farms employing 5-29 persons in the construction, manufacture, transportation and telecommunication industries obtained from the *Maitsuki Kinro Tokei* (Monthly Labor Statistics) with an unpublished weight depending on the gender and age of farm workers. Wage, P_L, is measured by dividing labor costs by the total number of hours worked. Land, T, is the size of paddy fields used for rice production measured in ha. Output, y, is measured in kg of brown rice. The price of brown rice per kg is defined as the division of gross sales by the total output.

In this study I use only 1991-1994 data, hence it is difficult to estimate many parameters in a translog profit function as Ito [1996] did. Therefore, I assume that factor markets are competitive, and use the estimates of factor shares for the production elasticity of each factor in the Cobb-Douglas production function, Eq. (1). The column of Actual Data Reported in the *KSC* in Table 4 shows the average factor shares used in production from 1991-1994. The factor shares of agricultural implements (*a2*) and labor (*a3*) decrease as farm size increases in the Tofuken and Hokkaido regions. Furthermore, the sum of factor shares for farms with smaller than 1 ha of area in rice cultivation exceeds one, hence those small farms are not profitable at all. These facts may reflect a situation where small farms do not use machines efficiently. It is also possible that the wages for the small farms are overvalued because most of their agricultural work is done on a part-time basis during the weekends and after non-farm work, whereas the *KSC* imputes full-time wages to estimate the opportunity cost of farming as explained above.

For the sake of estimating the technology in the flat agricultural areas, since I am interested in a situation where the farmland market works and the technology used by small farms is similar to that used by larger farms, I assume that the same technology is used by all 0-2 ha farms (0-3 ha farms in the Hokkaido region). This assumption is based on the following evidence. First, according to *The Current Situation of Japanese Farmland*, once the size of a paddy field becomes more than 0.3 ha, the farmland market starts working because it is then easier to use larger machines efficiently. According to the *White Paper on Agriculture* (1996), by consolidating smaller paddies into a paddy larger than 0.3 ha, the time worked in 0.1 ha of paddy was reduced to 33 hours a year on average -- approximately the same number of hours worked during a year on the farms with 1-2 ha of area in rice cultivation. Hence, I assume that in the flat agricultural areas, the factor shares of farms smaller than 1 ha are the same as those of 1-2 ha farms in the Tofuken region (1-3 ha farms in the Hokkaido region) as shown in the rows of "technology 1" in Table 4. To estimate efficiency parameter *A*, I adjusted the amount of inputs used by 0-1 ha farms so that they are proportional to those of 1-2 ha farm. I estimate *A* from Eq. (1) using 1994 data on output, *y*. The effect of weather is taken into account using the output index shown in *Sakumotsu Toukei* [Produce Statistics]. For the Hokkaido region, farms with less than 1.0 ha in rice production are assigned 1991 quantity data at 1994 prices because 1992 and 1994 data on those farms are not available and 1993 data seem to be affected by bad weather. All others are assigned 1994 price and quantity data.

As an estimate of the level of technology used by the farms in the rest of Japan, Eq. (8), I use the value of *a1* reported in the *KSC*, because there are no substantial differences in *a1* across farm size. The estimates of *A* are shown in the row labeled "Farms in the Rest of Japan" in Table 4.

Note that the market rent reported in the *KSC* stands the risk of being underestimated because it reflects the standard rent suggested by the local Agricultural Council. Therefore I will report the results of simulations which set *a4* equal to 0.4 for farms larger than 2 ha in the Tofuken region and farms larger than 5 ha in the Hokkaido region, and assumes technology 1 is used by the other smaller farms in the flat agricultural areas. The 0.4 figure is based on Fujiki's [1993] estimation of a Cobb-Douglas production function using 1981-1990 data on farms larger than 1.5 ha in size, and other Japanese studies discussed in Fujiki [1993]. The values for *A* in this special case are shown in the row labeled "Technology 2" in Table 4.

One might expect that technological progress will be induced by the consolidation of smaller paddies into a large paddy in the flat agricultural areas. Indeed, according to *The Current Situation of Japanese Farmland*, once all of paddy fields become larger than 0.3 ha, the time worked per 0.1 ha of paddy could be only 17.5 hours a year, which is almost the same as on farms larger than 10 ha. To capture such a situation, I assume that all farms in the flat agricultural areas can use technology with the same factor shares of production as farms with more than 10 ha, although the efficiency parameter *A* may differ. To estimate efficiency parameter *A*, I adjusted the amount of inputs attributed to 0-10 ha farms so that they are proportional to those of 10+ ha farms. The values for *A* in this case are shown in the row labeled "Technology 3" in Table 4.

C. Demand for Rice

I assume that the Japanese aggregate demand for rice has a constant own-price elasticity of -0.13 following Kako, Gemma and Ito [1997], and passes through the point where price equals 307 yen/kg (the average sales price in the Tofuken region in the 1994 *KSC*) and domestic consumption equals 10,220,000 tons (the total domestic consumption in 1994). I assume that the rice produced in the Tofuken region and in the Hokkaido region are close substitutes and that the price of rice produced in the Hokkaido region is always 15.52% below that of rice produced in the Tofuken region based on the 1994 *KSC*. Hence, I reduce the domestic consumption by the weight of 1994 rice production in the Hokkaido region (8%) and the Tofuken regions (92%), and aggregate the supply for the Hokkaido region by the weight of 0.8448.

D. Importation of Rice

Walles, Cramer, Chavez, and Hansen [1997] simulate the world rice market. They assume that Japan will gradually increase the importation of rice until it reaches the level of 758,000 tons of white rice in the year 2000, as promised in the GATT Uruguay Round Agreement. Their model estimates that the world price of Japonica in the year 2000 will be 0.431 U.S. dollars (FOB) per 1 kg in the year 2000 based on these assumptions. According to Kome Seisaku Kenkyukai [1991], the transportation cost from U.S. to Japan will be 0.085 $/kg. A 6% insurance charge, a 1.2% interest rate charge, and a commission of 3% on the shipment will be added to the sum of the transportation cost and the price of rice. This will make the price at the Japanese port 0.5701 $/kg, and if the exchange rate between the U.S. dollar and the Japanese yen is 100 yen/$, the price will be 57 yen/kg. Finally, it costs 7 yen/kg to bring rice through Japanese customs. In total, neglecting the transportation cost within Japan, one can buy foreign rice at 64 yen/kg.

It is more difficult to predict to what extent rice will be imported into Japan once its rice market is open. However, it is well known that the short run supply elasticities of rice in the potential exporting countries are small, and even in the long run, they are unlikely to be greater than one. For example, Tyers and Anderson [1993] suppose that the supply elasticities of rice in the U.S. and Australia, which will be the major suppliers of Japonica rice to Japan, are 0.35 and 0.2 in the short run, and 0.75 and 0.33 in the long run. Hence, in this paper, I assume that the importation of 758,000 tons of white rice (or 852,000 tons in brown rice units based on the computation of Honma [1994]) at 64 yen/kg is possible since this quantity is stipulated in the GATT Uruguay Round Agreement. I assume further that if Japan opens its market in the year 2000, the import supply curve will start at (64 yen/kg, 852,000 tons in brown rice units), with a Japanese domestic price elasticity of 0.3 for the inelastic case, and 1.0 for the elastic case. I.e., I assume that the Japanese demand for Japonica rice dictates the world price of Japonica rice. This is a reasonable assumption since in the year 2000, the Japanese imports of 758,000 tons of Japonica white rice will mean that Japan will import 36% of the total world Japonica rice exports according to the simulation of Walles, Cramer, Chavez, and Hansen [1997].

The Japanese government is likely to charge the tariff within the limits of the GATT Uruguay Round Agreement in the year 2000, because the current import quota, known as the minimum access approved by the Accord, is not valid after the year 2000. So far the Japanese government has levied a specific tax of 292 yen/kg on the minimum access importation of rice as a mark up. Although the Japanese government has not published the tariff equivalent regarding rice officially, it is plausible that the current mark up, 292 yen/kg, will become the tariff level in the year 2000. However, the GATT Uruguay Round Accord requires Japan to reduce the amount of the specific tax by at least 15% by the year 2000. Therefore, the most likely specific tax in the year 2000 is 85% of 292 yen/kg, i.e., 248 yen/kg. I assume this specific tax will be effective on the importation of rice after the year 2000.

IV. Simulations

A. Basic Results

The simulations try to answer the following question under a variety of circumstances: What would happen to the Japanese rice market in the year 2000? I first show the results of simulating domestic equilibrium with the current acreage control program as a base line. Second, I compare the results of simulation with the importation of 758,000 tons of white rice as the minimum access quota temporarily approved by the GATT Uruguay Round Accord in the year 2000, and the importation of rice subject to a specific tax within the limits of the Accord after the removal of the quota under the current acreage control program. Third, I show the results of simulating domestic equilibrium without an acreage control program, and free-import equilibrium without an acreage control program. In this section, I assume technology 1 is used in the flat agricultural area. The results of simulating Eq. (13) and Eq. (14) by changing the price of rice from 400 yen/kg to 50 yen/kg in increments of 1 yen under various assumptions are reported in Table 5 as simulations A-1 through A-6.

Simulation A-1 determines the market equilibrium under the acreage controls without imports. It predicts an equilibrium price of 327 yen/kg, and an equilibrium rent of 266,400 yen/ha in the Tofuken region and 321,400 yen/ha in the Hokkaido region. The predictions are close to the actual figures from 1994: the price of rice was 307 yen/kg, and the rent was 282,800 yen/ha in the Tofuken region and 257,800 yen/ha in the Hokkaido region. The aggregate supply function for rice exhibits a price elasticity of supply of 0.461 as shown in the row labeled A-1 in Table 6, which is consistent with a long run price elasticity of supply of 0.4 as assumed in Honma [1994] and Oga [1998]. However, the aggregate supply elasticity obtained in this paper is a weighted average of price elasticities of supply in the rest of Japan ($As2_1$ in Eq. (13)), 0.186, and that in the flat agricultural areas ($As1_1$+$As1_2$ in Eq. (13)), 1.571.

Simulation A-2 considers the effect if 852,000 tons of imported brown rice, which are equivalent to the 758,000 tons of white rice based on the computation of Honma [1994], are supplied in the Japanese rice market as a perfect substitute for Japanese rice under the acreage control program. It predicts an equilibrium rice price of 296 yen/kg as can be seen in Table 5. Given the fact that the current price of rice is 307 yen/kg, the effect of the minimum access reduces the price of rice by only 4%.

Simulation A-3 examines the case where the Japanese government levies a 248 yen/kg specific tax on foreign supply, which has a price elasticity of supply of 1.0. The price of rice becomes 298 yen/kg, and domestic supply increases slightly compared with the result of simulation A-2. Therefore, for the sake of protecting domestic production, the tariff is marginally effective compared with the minimum access to be accepted in the year 2000. However, the choice of tariff or quota does not alter the nature of equilibrium as long as acreage controls are given. I do not report the results of simulations assuming that the foreign price elasticity of supply is 0.3, since the results are not sensitive to the elasticity of the foreign supply curve as long as the specific tax of 248 yen/kg is essentially prohibitive.

Simulation A-4 considers the removal of the acreage control program by simulating the supply functions with acreage equal to the potential area in rice cultivation. It predicts an equilibrium price of 236 yen/kg (a 28% reduction relative to the results of simulation A-1). Note that the equilibrium rent falls approximately 65% compared with the results of simulation A-1 in both regions. Although the equilibrium price of rice falls substantially, the aggregate supply elasticity of rice is 0.439, which is close to that of simulation A-1 as reported in Table 6. Hence, as can be seen in Figure 1, the shift in the aggregate supply curve from A-1 to A-4 due to the removal of acreage control seems to be parallel.

Simulation A-5 examines the effect of removing acreage controls with an import elasticity of 0.3. The price of rice will be 195 yen/kg (a 36% reduction in the rice price compared with the 1994 price) and 11% of the Japanese rice market will be occupied by foreign suppliers. In the mean time, rents fall about 80% in both regions compared with the rents in 1994.

Simulation A-6 assumes an import elasticity of 1.0. The price of rice will be 161 yen/kg (a 48% reduction in the rice price compared with the 1994 price) and 20% of the Japanese rice market will be occupied by foreign suppliers. The level of rents decrease about 80% in both regions compared with the rents in 1994.

To quantify the dead weight loss and welfare gains to the consumers due to the current protection of domestically produced rice, Figure 2 is useful. Once the acreage control is removed, the equilibrium price of rice is 236 yen/kg, the supply curve shifts from A-1 to A-4, and the domestic equilibrium shifts from point A to point E. Therefore, with free importation from producers whose price elasticity of supply is 1.0, the dead weight loss is approximated by the area of triangle EDC in Figure 2, (236-161)*(10773 - 8591)/2 = 81,825 million Japanese yen. The loss is about 0.01 percent of the Japanese nominal GDP in 1995.

However, with acreage control program, the supply curve of simulation A-1 passes the output of 6,538,000 tons if the price of rice is 161 yen/kg (point B in Figure 2). If we evaluate the dead weight loss including the effect of acreage controls, the loss will be approximated by the area of triangle ABC in Figure 2, (327-161)*(10773-6538)/2 = 351,505 million Japanese yen, which is about 4.3 times larger than the efficiency losses after the removal of acreage control program. The result clearly demonstrates that most of the efficiency gains come from the removal of acreage controls, rather than from rice imports, if the Japanese government abolishes the acreage controls and allows the free importation of rice.

It is not surprising that the dead weight loss is relatively small because the price elasticity of demand for rice is small. However, the shift from point A to point E increases consumer surplus by 911,638 million Japanese yen, and the change from point A to point C indeed increases consumer surplus by 1,708,140 million Japanese yen (0.3% of the 1995 Japanese nominal GDP). Therefore, the potential gains for the Japanese consumers from the free importation of rice are very large despite the fact the dead weight loss is small.

The rows labeled A-1 through A-6 in Tables 7 and 8 report the equilibrium farm size in the flat agricultural areas in the Tofuken region and the Hokkaido region respectively. The results of simulation A-1 show a farmland concentration toward farms larger than 2 ha in the Tofuken region, farms larger than 10 ha in the Hokkaido region, and farms smaller than 0.3 ha in all of Japan. This result reflects the cross-sectional differences in the human capital and factor shares used in production. Note that larger values of *a4* and smaller values of q = *a1*+*a2*+*a3*+*a4* result in changes in the optimal farm size that are more than in proportion to the changes in the value of *A* (see Eq. (7)) for those farms shown in Table 4 given factor prices and the price of rice.

The results of simulations A-2 and A-3 show that with the small decrease in the equilibrium price of rice relative to simulation A-1, a concentration of farmland towards larger farms occurs. This reallocation of farmland is explained by the differences in the factor shares of production across farm size. For example, from simulation A-1 to simulation A-2, the price of rice falls 10%, and the rent in the Tofuken region falls 21%. Note that Eq. (7) shows that the percentage change in the optimal farm size as a result of changes in the prices of rice and rent is (1/1-q) $\hat{p}$ +{1+ (*a4*/1-q)} $\hat{p}_T$, where ^ denotes the percentage change. Note also in Table 4, that the values of (1/1-q) and {1+(*a4*/1-q)} for farms larger than 10 ha in the Tofuken region are 3.05 and 1.62, whereas those of farms smaller than 1 ha are 6.84 and 2 respectively. Since the total supply of farmland in the flat agricultural areas is fixed, the increase in the farm size of some groups must result in a decrease in the farm size of the other groups. Because the rent falls more than the price of rice, it is evident that the size of larger farms is increasing while the size of smaller farms is decreasing.

It is likely that the Japanese government will maintain the acreage control program even after the year 2000, making the results of simulation A-3 may perhaps the most plausible. The findings indicate that the importation of rice under a specific tariff barely affects the structure of Japanese rice production, and it slightly induces middle sized farmers to rent their farmland to the large-scale farmers.

Simulation A-4 demonstrates that with the removal of acreage controls, the optimal farm size increases compared to the potential area in cultivation for the farms larger than 2 ha in the Tofuken region, and farms larger than 10 ha in the Hokkaido region for the same reason as explained above. The results of simulations A-5 and A-6 show that under the free importation of rice, the concentration toward larger farms becomes evident compared with the results of simulation A-4. For example, farms larger than size 10 ha have an average equilibrium size of 44 ha and 55 ha in the Tofuken region, and 27 ha in the Hokkaido region.

The rows labeled A-1 to A-6 in Table 9 and Table 10 report the equilibrium farm income in the flat agricultural areas of the Tofuken region and the Hokkaido region respectively. The definition of farm income is as follows:

$$\mathit{Farm\ Income}_i \equiv p.y_i(1-a1-a2-a3-a4)+p_L\cdot \mathit{Family\ Labor}+p_T\cdot \text{own land}. \qquad (15)$$

Measures of farm income are common among Japanese statistical sources such as the *Nouka Keizai Cyosa* (1994) [Survey of Farm Households]. Values from this source are reported in the first three rows of Table 9. Unfortunately income data for the Hokkaido region are not available. Note that for farms of less than 5.0 ha, farm income is lower than non-farm income. In particular, farms of less than 0.5 ha depend exclusively on non-farm income as well as pensions. This is because in the typical, small rice-producing farms in Japan, young laborers are employees, and old and female laborers work in the paddy mainly for their own household consumption, they are just waiting for the chance to convert their paddies for non-agricultural purposes.

For the sake of comparison, I report the farm income obtained from rice production shown in the 1994 *KSC*. One should note that the farm income of 0.3-0.5 ha farms in *Nouka Keizai Cyosa* (1994) is substantially lower than that reported in the 1994 *KSC*. This could reflect a bias because the *KSC* tends to pick up more profitable farms.

Table 9 shows that simulation A-1 approximates the income of farms larger than 1 ha reasonably well, while farms smaller than 1 ha increase their farm income because their efficiency in rice production improves substantially under the assumption of technology 1.

For the sake of clarification, the composition of the 493,000 yen of farm income for 0.3-0.5 ha farms in the Tofuken region is as follows. First, note that since the area in rice cultivation and the optimal farm size are almost the same as we have seen in Table 7, the term relating to rent is negligible in Eq. (15). Therefore, the income could be the sum of two terms, $p.y_i(1-a1-a2)$ and $(p_L \cdot Family\,Labor - p.y_i a3)$. Note also that 242,000 yen of income as reported in the 1994 *KSC* is almost equal to $p.y_i(1-a1-a2)$. The reason for this is illustrated in Table 1, where we see that 0.3-0.5 ha farms are using solely family labor, hence $(p_L \cdot Family\,Labor - p.y_i a3)$ is almost zero. In simulation A-1, by assuming technology 1, the sales net of *V* and *K*, or $p.y_i(1-a1-a2)$, become about 1.6 times higher than those computed in the *KSC*. This reflects the lower values of *a1* and *a2*, changes in the price of rice from 307 yen/kg to 327 yen/kg, and the decrease in the yield per area. Net sales are thus roughly 400,000 yen. Regarding the term $(p_L \cdot Family\,Labor - p.y_i a3)$, technology 1 reduces the amount of family labor used on 0.3-0.5 ha farms by 40% compared with the amount reported in the *KSC*, which adds another 100,000 yen of farm income. Therefore, the farm income of 0.3-0.5 ha farms becomes close to 500,000 yen. Note that for the small farms, the savings on family labor typically account for 100,000-200,000 yen of farm income in simulations A-1, A-2 and A-3.

The results of simulations A-2 and A-3 predict relatively small decreases in farm income compared with the results of simulation A-1. The results of simulation A-4 suggest that by removing the acreage control program, the decrease in the price of rice and rent will reduce farm incomes relative to the results of simulation A-1. The results of simulation A-6 primarily predict that farms larger than 1 ha will suffer 30-50 % losses in their farm incomes compared with simulation A-1. Therefore, large-scale farming in the presence of the free trade of rice may not be profitable enough as long as we are using the current level of technology.

B. Sensitivity Analysis Regarding the Choice of Technology Parameters

Technology 2 sets *a4* equal to 0.4 for farms larger than 2 ha in the Tofuken region and farms larger than 5 ha in the Hokkaido region. This assumption is based on the uncertainty about whether the market rent reported in the *KSC* is underestimated, because it reflects the standard rent suggested by the local Agricultural Council. The results of simulating Eq. (13) and Eq. (14) by changing the price of rice from 400 yen/kg to 50 yen/kg in increments of 1 yen, under the assumption that technology 2 is used by the farms, are reported in Table 5 as simulations B-1 through B-6.

Simulation B-1 determines the market equilibrium under the current acreage controls without imports. It predicts an equilibrium price of 317 yen/kg, and an equilibrium rent of 532,500 yen/ha in the Tofuken region and 537,900 yen/ha in the Hokkaido region. Although the price of rice decreases 3% compared with the result of simulation A-1, the equilibrium rent is doubled in the Tofuken region and increases 67% in the Hokkaido region reflecting the higher marginal productivity of land on the larger farms, which increases the demand for farmland and increases the equilibrium rent. Because the aggregate supply function of rice exhibits a price elasticity of supply of 0.452 as shown in the row labeled B-1 in Table 6, it is natural that almost all of the aggregate supply figures are same as those reported in the results of simulation A-1.

Simulations B-2 and B-3 predict about a 3-4 % reduction in the price of rice, a more than 100% increase in the rent in the Tofuken region, and a 65-68% rent increase in the Hokkaido region compared with the results of simulations A-2 and A-3.

Simulation B-4 considers the removal of the acreage control program by simulating the supply functions with acreage equal to the potential area in rice cultivation. It predicts an equilibrium price of 210 yen/kg (a 11% reduction relative to the results of simulation A-4). Although the equilibrium price of rice falls substantially, the aggregate supply elasticity of rice is 0.451, and it is not so much different from those used in simulation B-1 as reported in Table 6. Again, the rent increases substantially in both regions relative to the results of simulation A-2. Figure 1 captures the shift of supply curves from A-2 to B-4 reflecting technical change.

Simulations B-5 and B-6 show about a 10% reduction in the rice price compared with the results of simulations A-5 and A-6, while the rent increases further. The rows labeled B-1 through B-6 in Tables 7 and 8 report the equilibrium farm size in the flat agricultural areas in the Tofuken region and the Hokkaido region respectively. The results of simulations show that farms of less than 1 ha in the Tofuken region and farms of less than 5 ha in the Hokkaido region essentially cease the production of rice, since the optimal farm size of less than 0.5 ha normally means that farms produce rice for their own family consumption.

Because of the higher productivity of larger farms, 2-3 ha farms and 3-5 ha farms in the Tofuken region make their optimal farm size 2-4 times larger compared with the corresponding results of simulations A-1 through A-6. In the Hokkaido region, farmland concentration occurs towards farms of more than 10 ha in simulations B-1 through B-6.

The rows labeled B-1 through B-6 in Tables 9 and 10 report the equilibrium farm income in the flat agricultural areas of the Tofuken region and those of the Hokkaido region respectively. Readers might wonder why the income of farmers smaller than 2 ha in the Tofuken region and smaller than 5 ha in the Hokkaido increased 4-15 % compared with simulations A-1 through A-6. This is because those farms essentially exited from the production of rice while enjoying higher rent payments from the larger farms, and saving almost all of their family labor. On the contrary, the income of farms larger than 5 ha in the Hokkaido region experienced a 2-13% decrease compared with the results of simulations A-1 through A-6, and the 2-3 ha farms and 5-10 ha farms in the Tofuken region suffer a 2-7% loss in farm income compared with the results of simulations A-1 through A-6.

To sum up, an increase in the value of *a4* for the larger farms reduces the equilibrium price of rice only 3-10%, while it increases the level of rent substantially compared with the results of simulations assuming technology 1. Higher land rental rates and lower rice prices induce small scale farm owners to become landlords. The income of smaller farms generally increases because they can save family labor and earn more rent, but the large-scale farms do not necessarily receive an increase in their farm income.

Regarding technology 3, which assumes the technology of larger farms in the flat agricultural areas is available to all farms in the flat agricultural areas given the differences in the human capital across farm size, the simulations are of limited interest since it presumes more investment in the farmland consolidation program. Therefore, I restrict my attention to only the cases where the acreage control program is removed, and the Japanese farmland market is liberalized.

The results of simulating Eq. (13) and Eq. (14) by changing the price of rice from 400 yen/kg to 50 yen/kg in increments of 1 yen, under the assumptions that the acreage control program is removed and free importation is allowed, are reported in Table 5 as simulations C-4, C-5 and C-6. The equilibrium price of rice falls 14-17% compared with simulations A-4, A-5 and A-6 respectively. The results of simulation C-4 shows that with equal factor shares across farm size, farmland now concentrates towards middle sized farms relative to the results of simulations A-4, A-5 and A-6 given the differences in human capital. The results suggest that technical change and larger scale operation are not always consistent, although the Japanese government regards large-scale tenant farming using faster and better machines as the most promising style of rice production in order to achieve lower rice prices. It is efficient to use better technology, as can be seen in the reduction in the price of rice compared with the results of A-4. However, once all farms can use the same technology up to the factor share of production, the concentration of farmland towards large-scale farms does not result from a decrease in the price of rice and rent given the human capital, *A*. Such results are consistent with the experience of Taiwan shown in Fujiki [1997], where the efficient production of rice was achieved based on contract farming given the prevalence of small-scale, part-time farms. Because all farms use the same factor share of production, the relative farm sizes are determined by the relative size of *A* alone, and the changes in the price of rice and rent do not alter the equilibrium allocation of farmland. Therefore, the optimal farm size reported in the results of simulations C-4, C-5 and C-6 are identical.

Of course, reflecting the changes in the price of rice and rents, farm incomes do change as can be seen in the rows labeled C-4, C-5 and C-6 in Tables 9 and 10. As expected, farms smaller than 3 ha in the Tofuken region and farms smaller than 5 ha in the Hokkaido region receive an increase in their farm income compared with the results of simulations A-4, A-5 and A-6, because their productive efficiency in improve further, despite the reduction in the price of rice. The farms smaller than 0.3 ha in the Hokkaido region is the exception, because an increase in their gross sales is dominated by the decrease in the savings on family labor and rent payments from the larger farms. Nonetheless, farms with relatively large size again experience a decrease in their farm income due to the reduction in the price of rice.

C. Wider Flat Agricultural Area

In this section, I assume technology 1 is used in the flat agricultural areas once again, but I assume that 0.421% of the farmland in the Tofuken region can be treated as flat agricultural area. This assumption means that the farmland market works in all of the paddies larger than 0.3 ha in the Agricultural Promotion Area irrespective of the slope of paddies as shown in row D of Table 2. The results of simulating Eq. (11) and Eq. (12) by changing the price of rice from 400 yen/kg to 50 yen/kg in increments of 1 yen, under various assumptions about the acreage control program and imports, are reported in Table 5 as simulations D-1 through D-6.

Compared with simulations A-1 through A-3, the results of simulations D-1 through D-3 imply that the price of rice is almost unchanged and the rent increases by at most 5%. Without acreage controls (simulations D-4, D-5, and D-6), the price of rice increases 7-11%, and the rent increases 18-31% compared with the results of simulations A-4, A-5 and A-6.

The rows labeled D-1 through D-6 in Tables 7 and 8 report the equilibrium farm size in the flat agricultural areas in the Tofuken region and the Hokkaido region respectively. The results of simulations D-1 through D-6 show that the optimal size of farms larger than 2 ha in the Tofuken region and farms larger than 5 ha in the Hokkaido region decreased compared with the results of simulations A-1 through A-6. The results indicate that the increase in the number of price elastic suppliers makes the aggregate supply curve more elastic (with a supply elasticity of 0.515 in the case of D-4 in Table 6). Therefore, there is a moderate decrease in aggregate supply given the same price of rice because more farms respond to the higher land rental rates, as can be seen in the shift of the supply curve from A-4 to D-4 in Figure 1. It is true that the total supply of flat areas increases. However, the rent increases by more than price of rice, making the optimal size of larger farms decrease while the optimal size of smaller farms increases compared with the results of simulations A-1 through A-6.

The rows labeled D-1 through D-6 in Tables 9 and 10 report the equilibrium farm income in the flat agricultural areas of the Tofuken region and the Hokkaido region respectively. It is evident that, reflecting the small increase in the price of rice compared with simulations A-1 through A-6, the equilibrium farm income increases.

V. Summary and Conclusion

The results of this study suggest that under the right conditions, a relaxation of trade barriers in the Japanese rice market would have only a minor adverse effect on Japanese rice-producing farms. If Japan imports rice under a specific tax of 248 yen/kg, as might be the case in the year 2000, the results of simulation A-3 imply that the structure of Japanese rice production would barely be affected. These findings are based on the assumption that the Japanese farmland market works reasonably well in the flat agricultural areas, where small, irregularly shaped paddies can be consolidated into paddies larger than 0.3 ha in size, and the efficient use of machinery becomes possible.

For the sake of protecting domestic production, a tariff set within the limits of the GATT Uruguay Round Accord would be more effective than the minimum access import quota currently accepted by the Japanese government (simulation A-2 versus simulation A-3).

If the current acreage control program is removed, there will be large-scale farms in equilibrium despite the 30% reductions in the price of rice caused by the removal of acreage controls (simulation A-4). The reduction of rice price and rents will cause structural changes in the farm size distribution reflecting the differences in the efficiency parameters and human capital levels across farm size, and large-scale tenant farming will prevail in the flat agricultural areas, although the farm income of larger farms will be reduced substantially in such a situation.

While the dead weight loss due to the import ban is relatively small given the inelastic demand for rice (Figure 2), potential gains in consumer surplus due to the free importation of rice could be 0.3 % of the Japanese GDP, because the price of rice could be halved (simulation A-6). Those results are not sensitive to the increase in the percentage of flat agricultural areas in the Tofuken region from 33% to 42% (simulations D-1 to D-6).

The increase in the value of *a4* for the larger farms will reduce the equilibrium price of rice by 3-10 %, while increasing the level of competitive rental substantially compared with the results of the simulations summarized above. This technology shock does induce further the structural changes in the farm size distribution (simulations B-1 through B-6).

Once all farms can share the same productivity parameters as those of large-scale farms, the differences in human capital alone will not induce further structural changes in the farm size distribution as the result of changes in the price of rice and rent, despite improved production efficiency. Such results are consistent with the experience of Taiwan discussed in Fujiki [1997], where the efficient production of rice based on contract farming, given the prevalence of small-scale, part-time farmers, became possible. Large scale tenant farming, which the Japanese government has been aiming for since 1970, is a promising way to achieve efficient production only if there exists a substantial divergence in the technology across farm size (Simulations C-4 through C-6).

The caveat for this study is as follows. First, I do not allow farms to convert paddies. Second, I do not allow for the possibility of entry by new organizations other than farm households. Third, if the small-scale farms will exit from rice production due to the retirement of old farmers, it will help to create large-scale farms. Even with these caveats in mind, I believe that the model discussed here should be a useful building block for the sake of policy recommendations and welfare evaluation, because it forecasts the endogenous farm size distribution, rent, and price of rice, and it discusses the interaction between the farmland market and the rice market explicitly.

References

EAGITSU, N. (1978). Nouka no Nougyoutousi. {Agricultural Investment by Farm Households}. In Inflation to Nihon Nougyou. {Inflation and Japanese Agriculture}, (Y. KATO and N. Egaitsu Eds.), 307-324, Tokyo University Press, Tokyo.

THE FORUM FOR POLICY INNOVATION. (1990). Kome kanzeika no eikyo ni tsuite {The Effect of Free Importation of Rice}, Forum for Policy Innovation, Tokyo.

FUJIKI, H. (1997). The Structure of Rice Production in Japan and Taiwan, *Economic Development and Cultural Change, forthcoming*.

FUJIKI, H. (1993). A Study of Japanese Ricemarket Liberalization, Ph.D.dissertation, University of Chicago.

GODO, Y. (1993). Policy Mix of Price Support and Acreage Allotment Programs in Japanese Rice Sector, *The Economic Review,* Hitotsubashi University 44, 32-40.

HAYAMI, Y. (1991). Institutional Aspects of Agricultural Development, in *The Agricultural Development of Japan* (Y. Hayami and S. Yamada Eds.), 61-108, Tokyo University Press, Tokyo.

HONMA, M. (1994). *Nougyoumondai no Seizikeizaigaku* {Political Economy of Agricultural Problems}. Nihonkeizai Shinbun, Tokyo.

IMAMURA, N. (1968). *Inasaku no Kaisoukan Kakusa*. {Farm Size and the Differences in the Techniques of the Production of Rice}. Nouseicyosa Iinkai, Tokyo.

ITO, J. (1996). Inasakuno kozouhenkato sono chiikisei. {Structural Changes in the Regional Production of Rice}. *Nougyousougoukenkyu* 50, 1-45.

KAKO, T, M GEMMA and S ITO. (1997). Implications of the Minimum Access Rice Import on Supply and Demand of Rice in Japan, *Agricultural Economics* 16, 193-204.

KAJI, I. (1973). *Syoukigyounou no Sonritu youken*. {Conditions for the Existence of Small Farms}. University of Tokyo Press, Tokyo.

KOME SEISAKU KENKYUKAI, (1991). *Kome yunyu ziyuka no eikyo* {The Effect of Japanese Free Importation of Rice}. Fuminkyokai, Tokyo.

OGA, K, (1988). *Kome no kokusai zyukyu to yunyu ziyuuka mondai* {The Problems of Japanese Free Importation of Rice}. Norintokei Kyokai, Tokyo.

TYERS, R, and K ANDERSON. (1992). *Disarray in World Food Markets,* Cambridge University Press, New York.

WAILES, E, G CRAMER, E CHAVEZ, and J HANSEN. (1997). Baseline Projections of Global Rice Trade, Production, Consumption and Prices for 1996-2010. In Final Report of the International Scientific Research Program of Ministry of Education, Science and Culture, Japanese Government. Tokyo.

Table 1: Percentage of Family Labor and Owner-Tiller Cultivation

Tofuken Region, Farm Size (ha)	0-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0+
Percentage of Family Labor	98.1	98.8	98.9	97.2	98.1	97.6	97.1	95.7
Percentage of Own Land	96.7	92.6	88.9	86.8	80.8	65	50.3	35.6
Hokkaido Region, Farm Size (ha)	0-0.3	0.3-0.5	0.5-1.0	1.0-3.0	3.0-5.0	5.0-10.0	10.0+	
Percentage of Family Labor	97.2	98.8	99.1	96.6	93.5	98.3	95.9	
Percentage of Own Land	94.5	93.1	89.7	85.7	89.7	92.3	76.2	

Source: The *Kome Seisanhi Chosa* [Survey of Rice Production Costs] 1994. Data on 0-0.3, 0.3-0.5, and 0.5-1.0 ha farms in the Hokkaido region are obtained from the 1993 survey.

Table 2：Flat Agricultural Areas

		Hokkaido	Tofuken
(A)	Total Paddy Field (1000 ha)	241	2541
(B)	Paddies Larger Than 0.3 ha	215	1209
(B/A)		0.892	0.475
	Within Agriculture Promotion Area		
(C)	Total Paddy Field (1000 ha)	234	1965
(D)	Paddies Larger Than 0.3 ha	209	1069
(D/A)		0.869	0.421
	Within Agriculture Promotion Area, Slope Less Than 1/100		
(E)	Total Paddy Field (1000 ha)	208	1383
(F)	Paddies Larger Than 0.3 ha	189	836
(F/A)		0.786	0.329

Source*: The Current Situation of Japanese Farmland*, Ministry of Agriculture, Forestry and Fisheries, 1994.

Table 3: Japanese Rice-Producing Farm Size Distribution

Tofuken Region, Farm Size (ha)	0-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0+	Total
Farms	427186	598550	691255	388289	99199	46993	12707	2023	2266202
(%)	18.9	26.4	30.5	17.1	4.4	2.1	0.6	0.1	
Area in Rice Production (ha)	83078	220122	465211	513477	230642	168872	78927	28390	1788719
(% of Total Area in Production)	4.6	11.1	23.4	25.8	11.6	8.5	4.0	1.4	
Hokkaido Region, Farm Size (ha)	**0-0.3**	**0.3-0.5**	**0.5-1.0**	**1.0-3.0**	**3.0-5.0**	**5.0-10.0**	**10.0+**		**Total**
Farms	765	1303	2152	6846	7078	11656	4346		34146
(%)	2.2	3.8	6.3	20.0	20.7	34.1	12.7		
Area in Rice Production (ha)	139	444	1383	12292	25940	77116	53382		170696
(% of Total Area in Production)	0.1	0.3	0.8	7.2	15.2	45.2	31.3		

Source: *The Agricultural Census 1995*.

Table 4: Factor Shares in Rice Production

Tofuken Region, Farm Size (ha)	0-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0+
Actual Data Reported in the *KSC*								
a1	0.191	0.191	0.169	0.144	0.137	0.136	0.137	0.144
a2	0.355	0.311	0.279	0.218	0.186	0.169	0.154	0.154
a3	0.529	0.485	0.425	0.325	0.257	0.234	0.205	0.170
a4	0.143	0.132	0.153	0.166	0.182	0.193	0.221	0.203
a1+a2+a3+a4	1.219	1.120	1.027	0.855	0.763	0.733	0.719	0.673
Technology 1								
a1	0.144	0.144	0.144	0.144	0.137	0.136	0.137	0.144
a2	0.218	0.218	0.218	0.218	0.186	0.169	0.154	0.154
a3	0.325	0.325	0.325	0.325	0.257	0.234	0.205	0.170
a4	0.166	0.166	0.166	0.166	0.182	0.193	0.221	0.203
A	2.939	3.065	3.327	3.692	10.751	17.738	26.340	43.874
Technology 2								
a1	0.144	0.144	0.144	0.144	0.137	0.136	0.137	0.144
a2	0.218	0.218	0.218	0.218	0.186	0.169	0.154	0.154
a3	0.325	0.325	0.325	0.325	0.257	0.234	0.205	0.170
a4	0.166	0.166	0.166	0.166	0.400	0.400	0.400	0.400
A	2.939	3.065	3.327	3.692	3.253	5.209	8.310	10.866
Technology 3								
a1	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144
a2	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
a3	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
a4	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
A	12.702	14.390	17.431	21.999	26.935	31.558	36.940	44.502
Farms in the Rest of Japan								
a1	0.191	0.191	0.169	0.145	0.137	0.137	0.138	0.144
A	10.862	10.610	12.844	15.986	17.598	17.823	17.285	16.158

Hokkaido Region, Farm Size (ha)	0-0.3	0.3-0.5	0.5-1.0	1.0-3.0	3.0-5.0	5.0-10.0	10.0+
Actual Data Reported in the *KSC*							
a1	0.198	0.195	0.173	0.152	0.157	0.137	0.168
a2	0.369	0.314	0.289	0.210	0.218	0.152	0.171
a3	0.520	0.496	0.435	0.316	0.312	0.234	0.224
a4	0.150	0.143	0.159	0.136	0.179	0.178	0.216
a1+a2+a3+a4	1.236	1.147	1.056	0.813	0.867	0.701	0.780
Technology 1							
a1	0.152	0.152	0.152	0.152	0.157	0.137	0.168
a2	0.210	0.210	0.210	0.210	0.218	0.152	0.171
a3	0.316	0.316	0.316	0.316	0.312	0.234	0.224
a4	0.136	0.136	0.136	0.136	0.179	0.178	0.216
A	4.180	4.316	4.819	5.811	4.156	32.742	15.497
Technology 2							
a1	0.152	0.152	0.152	0.152	0.157	0.137	0.168
a2	0.210	0.210	0.210	0.210	0.218	0.152	0.171
a3	0.316	0.316	0.316	0.316	0.312	0.234	0.224
a4	0.136	0.136	0.136	0.136	0.179	0.400	0.400
A	4.180	4.316	4.819	5.811	4.156	7.567	4.134
Technology 3							
a1	0.168	0.168	0.168	0.168	0.168	0.168	0.168
a2	0.171	0.171	0.171	0.171	0.171	0.171	0.171
a3	0.224	0.224	0.224	0.224	0.224	0.224	0.224
a4	0.216	0.216	0.216	0.216	0.216	0.216	0.216
A	6.647	6.963	7.932	9.877	12.380	13.957	15.580

Source: The *Kome Seisanhi Chosa* [Survey of Rice Production Costs] 1991-1994.

Table 5: Equilibrium Price, Rent, and Domestic Supply

Simulation	Acreage Controls	Import Elasticity	Tariff (yen/kg)	P (yen/kg)	P_T (yen/ha) Tofuken	Hokkaido	Ds (1000 ton)	Dd (1000 ton)	Ds/Dd (%)
A-1	Yes			327	266,400	321,400	9,807	9,807	100
A-2	Yes	0	Min Ac.	296	199,900	253,400	9,093	9,953	91
A-3	Yes	1	248	298	203,800	257,500	9,138	9,944	92
A-4	No			236	91,100	105,600	10,229	10,229	100
A-5	No	0.3	0	195	54,200	67,900	9,307	10,508	89
A-6	No	1	0	161	32,900	43,900	8,591	10,773	80
B-1	Yes			317	532,500	537,900	9,838	9,838	100
B-2	Yes	0	Min Ac.	284	411,000	419,700	9,145	10,006	91
B-3	Yes	1	248	288	424,700	433,200	9,229	9,988	92
B-4	No			210	198,700	199,300	10,377	10,377	92
B-5	No	0.3	0	174	128,800	130,800	9,496	10,664	89
B-6	No	1	0	148	89,100	91,200	8,888	10,891	82
C-4	No			202	111,700	97,500	10,452	10,452	100
C-5	No	0.3	0	162	73,700	58,800	9,610	10,764	89
C-6	No	1	0	139	55,300	41,400	9,094	10,980	83
D-1	Yes			329	271,200	326,100	9,810	9,810	100
D-2	Yes	0	Min Ac.	302	211,700	265,800	9,070	9,927	91
D-3	Yes	1	248	303	213,800	267,900	9,096	9,922	92
D-4	No			254	111,800	125,500	10,137	10,137	100
D-5	No	0.3	0	216	71,500	86,000	9,128	10,369	88
D-6	No	1	0	179	43,300	55,900	8,241	10,625	78

Note: Ds is domestic supply, Dd is domestic demand, Min Ac. is minimum access import quota of 852,000 tons of brown rice.

Table 6：Price Elasticity of Supply of Rice

Simulation	Aggregate Supply	The Flat Agricultural Areas	The Rest of Japan
A-1	0.461	1.571	0.186
A-4	0.439	1.577	0.187
B-1	0.452	1.349	0.186
B-4	0.451	1.340	0.187
C-4	0.374	0.960	0.187
D-1	0.543	1.586	0.186
D-4	0.515	1.592	0.187

Table 7：Equilibrium Average Farm Size (ha) in the Flat Agricultural Areas in the Tofuken Region

Tofuken, Farm Size (ha)			0-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0+
Area in Rice Cultivation (ha)			0.205	0.387	0.709	1.393	2.450	3.786	6.544	14.785
Simulation	P	P_T								
A-1	327	266,400	0.266	0.373	0.614	1.206	2.628	4.889	10.371	16.263
A-2	296	199,900	0.248	0.348	0.572	1.124	2.868	5.521	12.160	19.110
A-3	298	203,800	0.249	0.350	0.575	1.130	2.852	5.477	12.032	18.905
Potential Area in Rice Cultivation (ha)			0.318	0.522	0.951	1.846	3.212	4.950	8.569	19.302
Simulation	P	P_T								
A-4	236	91,100	0.281	0.395	0.649	1.276	4.427	9.151	22.147	34.205
A-5	195	54,200	0.230	0.323	0.531	1.043	4.956	10.951	28.422	44.311
A-6	161	32,900	0.179	0.252	0.414	0.813	5.338	12.624	35.091	55.434
Area in Rice Cultivation (ha)			0.205	0.387	0.709	1.393	2.450	3.786	6.544	14.785
Simulation	P	P_T								
B-1	317	532,500	0.048	0.068	0.112	0.219	10.287	9.891	10.530	18.561
B-2	284	411,000	0.039	0.055	0.091	0.179	9.551	11.526	12.824	22.909
B-3	288	424,700	0.040	0.057	0.094	0.184	9.676	11.318	12.516	22.318
Potential Area in Rice Cultivation (ha)			0.318	0.522	0.951	1.846	3.212	4.950	8.569	19.302
Simulation	P	P_T								
B-4	210	198,700	0.023	0.033	0.054	0.106	10.986	19.783	23.785	43.506
B-5	174	128,800	0.016	0.023	0.038	0.074	7.844	23.888	31.799	59.995
B-6	148	89,100	0.012	0.016	0.027	0.053	5.302	27.117	39.913	77.641
Potential Area in Rice Cultivation (ha)			0.318	0.522	0.951	1.846	3.212	4.950	8.569	19.302
Simulation	P	P_T								
C-4	202	111,700	0.341	0.505	0.893	1.801	3.449	5.664	9.155	15.949
C-5	162	73,700	0.341	0.505	0.893	1.800	3.449	5.663	9.153	15.945
C-6	139	55,300	0.340	0.504	0.891	1.796	3.441	5.650	9.132	15.908
Area in Rice Cultivation (ha)			0.205	0.387	0.709	1.393	2.450	3.786	6.544	14.785
Simulation	P	P_T								
D-1	329	271,200	0.267	0.375	0.616	1.210	2.612	4.851	10.265	16.096
D-2	302	211,700	0.251	0.353	0.581	1.142	2.820	5.392	11.787	18.514
D-3	303	213,800	0.252	0.354	0.582	1.143	2.811	5.367	11.718	18.405
Potential Area in Rice Cultivation (ha)			0.318	0.522	0.951	1.846	3.212	4.950	8.569	19.302
Simulation	P	P_T								
D-4	254	111,800	0.300	0.422	0.694	1.364	4.203	8.470	19.947	30.722
D-5	216	71,500	0.257	0.361	0.593	1.165	4.675	9.968	24.922	38.652
D-6	179	43,300	0.206	0.290	0.476	0.936	5.136	11.698	31.311	49.091

Table 8： Equilibrium Average Farm Size (ha) in the Flat Agricultural Areas in the Hokkaido Region

Hokkaido, Farm Size (ha)			0-0.3	0.3-0.5	0.5-1.0	1.0-3.0	3.0-5.0	5.0-10.0	10.0+
Area in Rice Cultivation (ha)			0.136	0.254	0.481	1.343	2.741	4.949	9.188
Simulation	P	P_T							
A-1	327	321400	0.171	0.208	0.371	0.834	2.104	4.190	13.113
A-2	296	253400	0.152	0.184	0.328	0.738	1.741	4.388	13.360
A-3	298	257500	0.153	0.186	0.331	0.744	1.763	4.374	13.344
Potential Area in Rice Cultivation (ha)			1.092	1.056	1.421	2.999	5.272	9.053	16.487
Simulation	P	P_T							
A-4	236	105,600	0.205	0.249	0.443	0.995	2.480	8.306	27.047
A-5	195	67,900	0.158	0.192	0.342	0.769	1.669	8.875	27.277
A-6	161	43,900	0.120	0.146	0.261	0.586	1.103	9.376	27.117
Area in Rice Cultivation (ha)			0.136	0.254	0.481	1.343	2.741	4.949	9.188
Simulation	P	P_T							
B-1	317	537,900	0.060	0.073	0.129	0.291	0.498	3.547	18.478
B-2	284	419,700	0.051	0.062	0.110	0.248	0.391	3.958	17.654
B-3	288	433,200	0.052	0.063	0.113	0.253	0.403	3.901	17.738
Potential Area in Rice Cultivation (ha)			1.092	1.056	1.421	2.999	5.272	9.053	16.487
Simulation	P	P_T							
B-4	210	199,300	0.037	0.045	0.079	0.179	0.233	7.915	33.325
B-5	174	130,800	0.028	0.034	0.060	0.135	0.153	9.350	29.613
B-6	148	91,200	0.022	0.026	0.047	0.106	0.106	10.671	26.170
Potential Area in Rice Cultivation (ha)			1.092	1.056	1.421	2.999	5.272	9.053	16.487
Simulation	P	P_T							
C-4	202	97,500	0.378	0.474	0.849	2.035	5.884	9.612	16.019
C-5	162	58,800	0.378	0.474	0.849	2.035	5.884	9.611	16.018
C-6	139	41,400	0.378	0.474	0.849	2.035	5.883	9.610	16.016
Area in Rice Cultivation (ha)			0.136	0.254	0.481	1.343	2.741	4.949	9.188
Simulation	P	P_T							
D-1	329	326,100	0.173	0.210	0.374	0.840	2.129	4.178	13.099
D-2	302	265,800	0.155	0.189	0.337	0.757	1.809	4.348	13.313
D-3	303	267,900	0.156	0.190	0.338	0.760	1.821	4.341	13.306
Potential Area in Rice Cultivation (ha)			1.092	1.056	1.421	2.999	5.272	9.053	16.487
Simulation	P	P_T							
D-4	254	125,500	0.225	0.273	0.487	1.094	2.870	8.064	26.824
D-5	216	86,000	0.182	0.221	0.393	0.883	2.066	8.571	27.174
D-6	179	55,900	0.140	0.170	0.303	0.681	1.386	9.090	27.184

Table 9： Equilibrium Farm Income (1000 yen) in the Flat Agricultural Area in the Tofuken Region

Tofuken, Farm Size (ha)			0-0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0+
Farm Income 1994 (1000 yen)*			n.a.	80	428	963	2,051	3,894	7,556	
Non-Farm Income 1994 (1000 yen)*			n.a.	6,464	6,868	6,707	6,334	5,883	3,638	
Pensions and Grants 1994 (100 yen)*			n.a.	2,287	2,210	1,817	1,655	1,689	1,461	
Farm Income in 1994 *KSC* (1000 yen)**			164	242	530	1,002	2,319	3,335	5,546	10,058
Simulation	P	P_T								
A-1	327	266,400	354	493	828	1,465	2,679	4,343	7,506	14,533
A-2	296	199,900	322	441	739	1,289	2,352	3,817	6,650	12,726
A-3	298	203,800	324	444	744	1,299	2,371	3,849	6,703	12,837
A-4	236	91,100	289	382	636	1,084	1,934	3,138	5,600	10,398
A-5	195	54,200	266	347	574	964	1,640	2,623	4,681	8,537
A-6	161	32,900	253	328	541	899	1,451	2,272	4,010	7,198
Simulation	P	P_T								
B-1	317	532,500	369	541	927	1,658	2,682	4,337	7,186	14,730
B-2	284	411,000	336	482	822	1,451	2,310	3,798	6,304	12,781
B-3	288	424,700	340	489	833	1,474	2,353	3,861	6,406	13,004
B-4	210	198,700	305	413	696	1,200	1,859	3,105	5,178	10,288
B-5	174	128,800	281	373	624	1,061	1,579	2,632	4,418	8,639
B-6	148	89,100	267	351	584	983	1,426	2,337	3,940	7,609
Simulation	P	P_T								
C-4	202	111,700	335	452	764	1,344	2,095	3,104	4,868	8,651
C-5	162	73,700	302	402	673	1,164	1,762	2,570	3,983	6,943
C-6	139	55,300	286	377	629	1,077	1,600	2,310	3,553	6,113
Simulation	P	P_T								
D-1	329	271,200	356	497	835	1,478	2,702	4,380	7,564	14,656
D-2	302	211,700	327	450	754	1,320	2,411	3,914	6,809	13,060
D-3	303	213,800	328	452	757	1,325	2,421	3,930	6,836	13,116
D-4	254	111,800	303	403	671	1,154	2,087	3,397	6,047	11,309
D-5	216	71,500	276	363	602	1,019	1,781	2,874	5,134	9,453
D-6	179	43,300	259	337	557	930	1,545	2,449	4,354	7,884

Note: The figures for 1-2 ha farms are from actual data on 1-1.5 ha farms. The figures for 2-3 ha farms are from actual data on 2-2.5 ha farms. Those figures are based on The 1994 *Nouka Keizai Cyosa*. The KSC figure for 1-2 ha farms is from actual data on 1-1.5 ha farms.

Table 10： Equilibrium Farm Income (1000 yen) in the Flat Agricultural Area in the Hokkaido Region

Hokkaido, Farm Size (ha)			0-0.3	0.3-0.5	0.5-1.0	1.0-3.0	3.0-5.0	5.0-10.0	10.0+
Farm Income in 1994 *KSC* (1000 yen)*			n.a.	n.a.	n.a.	2,300	3,110	5,766	10,076
Simulation	P	P_T							
A-1	327	321,400	327	477	795	1,607	3,399	6,430	10,992
A-2	296	253,400	295	432	713	1,404	3,038	5,699	9,521
A-3	298	257,500	297	434	718	1,415	3,059	5,743	9,611
A-4	236	105,600	352	450	691	1,267	2,767	5,006	8,394
A-5	195	67,900	296	392	605	1,081	2,457	4,202	6,749
A-6	161	43,900	263	358	554	972	2,283	3,663	5,678
Simulation	P	P_T							
B-1	317	537,900	325	493	831	1,743	3,689	5,602	9,585
B-2	284	419,700	294	445	742	1,512	3,288	4,970	8,269
B-3	288	433,200	297	451	752	1,538	3,332	5,042	8,418
B-4	210	199,300	435	525	781	1,452	3,100	4,681	7,629
B-5	174	130,800	355	447	673	1,222	2,720	3,992	6,248
B-6	148	91,200	310	402	612	1,092	2,503	3,586	5,460
Simulation	P	P_T							
C-4	202	97,500	351	453	699	1,300	3,114	4,411	6,940
C-5	162	58,800	294	393	611	1,103	2,678	3,682	5,670
C-6	139	41,400	268	366	571	1,015	2,482	3,353	5,099
Simulation	P	P_T							
D-1	329	326,100	329	480	801	1,621	3,425	6,481	11,093
D-2	302	265,800	301	440	728	1,440	3,101	5,834	9,792
D-3	303	267,900	301	441	730	1,446	3,112	5,857	9,837
D-4	254	125,500	383	482	739	1,371	2,945	5,413	9,243
D-5	216	86,000	323	419	645	1,168	2,601	4,592	7,542
D-6	179	55,900	279	375	579	1,025	2,367	3,934	6,212

Note: The figures for 1-3 ha farms are from actual data on 2-3 ha farms. The 1994 *Nouka Keizai Cyosa* does not report the firm income, non-farm income or pensions and grants for the rice producing farms in the Hokkaido region.

Figure 1

Supply Curves

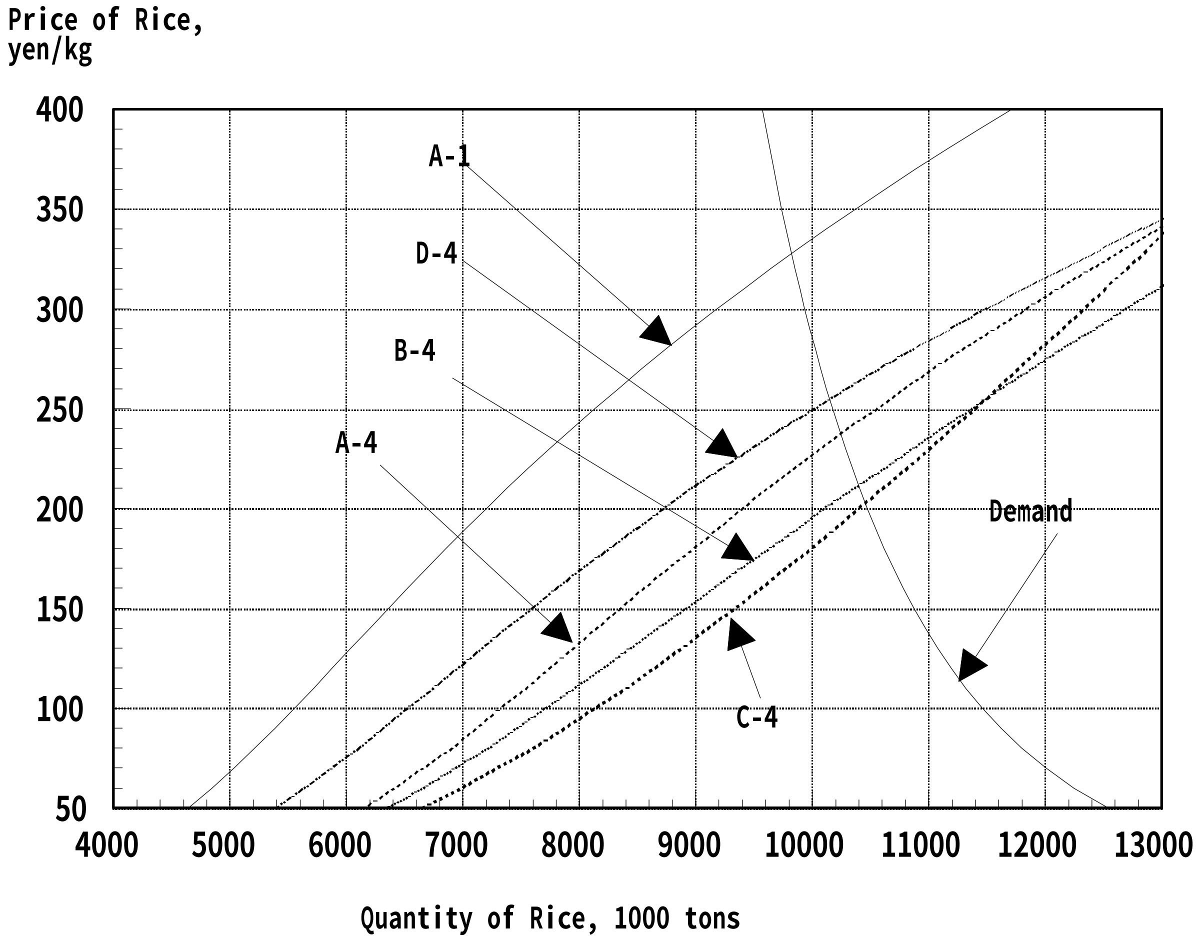

Figure 2

Effects of the Removal of Acreage Controls and

Free Importation of Rice